Oscillator Strengths for VUV lines of CO, H_2, and HCl

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Incomplete or inconsistent molecular parameters contribute to many of the difficulties and anomalies that arise in interpreting observations of molecules in diffuse and translucent interstellar clouds and planetary atmospheres and in modelling those environments. As a consequence, the acquisition of improved photoabsorption cross section and spectroscopic data for molecules (*e.g.*, CO, N_2, H_2O, SO_2, HCl) at UV and VUV wavelengths has been a major focus of our research program in the past few years.

We have studied the photoabsorption cross sections of the $d(15)$, $a'(20)$, $d(14)$, $a'(19)$, $a'(17)$, $d(12)$, $a'(16)$, $d(11)$, $e(8)$, $d(10)$, $a'(14)$, $e(5)$, $d(7)$, $e(4)$, and $a'(11)-X(0)$ intersystem (*i.e.*, spin-changing) bands of CO at 77 K using the 6VOPE spectrometer at the Photon Factory (Ito *et al.* 1985) and synchrotron radiation as a background continuum source. Cooling significantly reduces the number of rotational levels populated and thus overlapping with the lines of the much stronger $A-X$ bands. Federman *et al.* (1994) detected some of these intersystem bands in observations with the GHRS on HST along the line of sight to ζ Oph. The intersystem bands are relatively weak and, therefore, more likely than 'allowed' bands to be on the linear portions of curves-of-growth. The f-values are the most likely cause of the discrepancies between observed and modelled spectra.

We have also studied two absorption bands of H_2O, $C-X$ at ~124 nm and $F-X$ at 116 nm. The analysis of the measurements is almost complete. In addition, we have remeasured the absorption cross sections of the $C(0)-X(0)$ and $C(1)-X(0)$ bands of HCl. Our peak cross sections are significantly larger than in previous work, demonstrating that high spectral resolving power is required for accurate cross section measurements of narrow spectral features. Measurements on N_2 and SO_2 are discussed elsewhere at this workshop; measurements on some $E-X$, $B-X$, and $C-X$ bands of CO are planned.

References:

Federman, S. R., J. A. Cardelli, Y. Sheffer & D. L. Lambert 1994, Astrophys. J. Lett. 432, L139.

Ito, K., T. Namioka, Y. Morioka, T. Sasaki, H. Noda, K. Goto, T. Katayama & M. Koike 1985, Appl. Opt. 25, 837.

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